

# OBJECT CONSOLIDATION THROUGH SEQUENTIAL MATERIAL DEPOSITION

**THROUGH SEQUENTIAL MATERIAL DEPOSITON**

This application claims benefit of Provisional App. 60/154,250 filed Sep 16, 1999  
and 60/155,615 filed Sep 23, 1999, 60/156,257 filed Sep 27, 1999 and 60/157,572 filed Oct.  
4, 1999.

**Field of the Invention**

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The present invention relates generally to fabrication of objects and prototypes through the sequential deposition of material. More particularly, the invention relates to object fabrication using ultrasonic, electrical resistance, and frictional consolidation methodologies.

### Background of the Invention

Numerous manufacturing technologies exist for producing objects by sequentially adding material, with the casting of liquid metal being perhaps the oldest such technique. In the past two decades, however, various processes for fabricating objects to net shape primarily through material addition, i.e. without a finishing step such as machining to produce detailed, high-precision features, have been patented and, in a few cases, commercialized.

Most of these additive manufacturing processes either rely on an adhesive, or a solidification process in order to produce a bond between previously deposited material and each incremental volume of material which is added. Although the use of adhesives is convenient, the properties of the adhesive control the properties of the finished object, and this limits the usefulness of such processes in the production of engineering parts and products.

Particularly with regard to the production of metal objects, prior-art methods based on solidification transformations require the presence of liquid metal. Various approaches to the problem include three-dimensional shape melting or shape welding, as